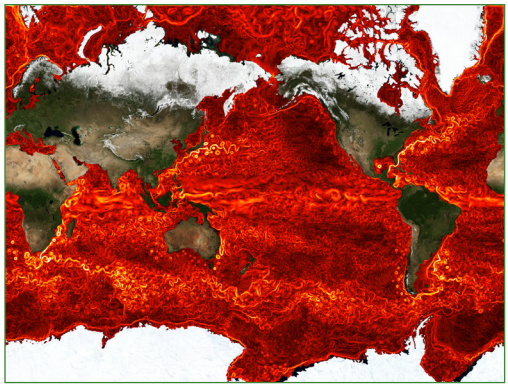
High-End Ocean State Estimates: Application to Real-World Challenges

Science Mission Directorate

NASA has unique capabilities in developing and deploying advanced satellite observing systems. Data from these instruments allows us to develop scientific insights into how (and why) the global earth system is changing, and to improve the understanding of life-supporting planetary cycles.

Under the Estimating the Climate and Circulation of the Ocean 2 (ECCO2) project, scientists at NASA and MIT are working together, using advanced computation to reconstruct the state of the Earth's ocean and sea-ice system. These three-dimensional, time-evolving reconstructions result in detailed information about variations in quantities such as ocean current patterns and temperature, sea-ice cover, global mass distribution, and sea level—spanning nearly 20 years.

In addition to helping develop a core understanding of how the ocean and sea-ice systems work, this information provides scientific input into real-world issues, including: monitoring the ocean-atmosphere exchange of carbon dioxide; forecasting the likely impact of pollutant plumes, such as the Deepwater Horizon; and improving estimates of Antarctic glacial melting.



Surface current speeds from a 1/16-degree-resolution simulation. The currents and associated 3D full ocean state can be used to drive applications such as: improved melt-rate estimates for the Antarctic ice sheet; enhanced estimates of ocean carbon dioxide uptake due to physical and biological processes; and quantification of uncertainty in projections of surface pollutant transports. *Chris Henze, NASA/Ames*

We have developed simulation tools uniquely suited to combining models and observations to monitor the ocean and sea-ice climate. Our computations have data-intensive characteristics, and require thousands of compute cores, hundreds of terabytes of permanent storage, and multiple terabytes of RAM in an iterative optimization process. NASA supercomputers are among the few available platforms that can handle the scale of computation, data processing, analysis, and visualization required.

Chris Hill, Massachusetts Institute of Technology
cnh@mit.edu